

# FORMULATION OF LOW CALORIE MULTIGRAIN COOKIES USING SUGAR REPLACER (PALM CANDY) AND FAT REPLACER (POLYDEXTROSE) AND ASSESSMENT OF PHYSICAL AND SENSORY PARAMETERS OF FORMULATED COOKIES

INDUMATHI. P<sup>1</sup> & SARAVANKUMAR. R<sup>2</sup>

<sup>1</sup>PG Scholar, Department of Food Science and Nutrition, Community Science College and Research Institute  
Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

<sup>2</sup>Associate Professor (FSN), Department of Food Science and Nutrition, Community Science College and Research Institute  
Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

## ABSTRACT

The aim of the study was to formulate low calorie multigrain cookies using refined wheat flour, finger millet flour, pearl millet flour, roasted green gram flour, palm candy (sugar replacer) and polydextrose (fat replacer). The multigrain composition ratio (refined wheat flour: finger millet flour: roasted green gram flour) used for cookie preparation were, 50:10:40 (T<sub>1</sub>), 50:20:30 (T<sub>2</sub>), 50:25:25 (T<sub>3</sub>), 50:30:20 (T<sub>4</sub>), 50:40:10 (T<sub>5</sub>) and another composition (refined wheat flour: pearl millet flour: roasted green gram flour) were, 50:10:40 (T<sub>6</sub>), 50:20:30 (T<sub>7</sub>), 50:25:25 (T<sub>8</sub>), 50:30:20 (T<sub>9</sub>), 50:40:10 (T<sub>10</sub>). Replacement of sugar with palm candy was tried at various levels (20, 25 & 30g) and it was standardized (30g). Likewise, fat replacer (polydextrose) was standardized as 30% from the trails 10 to 50 per cent. The prepared cookies were given for sensory evaluation to 15 members using 9– point hedonic scale. Based on the sensory evaluation T<sub>10</sub> (8.2) obtained the highest score followed by T<sub>5</sub>, T<sub>9</sub> & T<sub>4</sub> (8.1, 7.93 and 7.65 respectively). Physical parameters such as thickness, diameter, spread ratio and weight loss were measured before & after baking whereas cookies weight, bulk density & hardness were measured only for the final product. For the treatment T<sub>10</sub>, T<sub>5</sub>, T<sub>9</sub> & T<sub>4</sub> the weight of the cookies were in the range of 44.2 to 37.761 g and bulk density were in the range of 0.91 to 0.81 g/ml. Diameter, thickness & spread ratio was increased in baked cookies when compared to unbaked cookies in all treatments whereas the spread ratio value decreased in baked cookies of control sample.

**KEYWORDS:** Refined Wheat Flour, Finger Millet Flour, Pearl Millet Flour, Roasted Green Gram Flour, Palm Candy, Polydextrose & Sensory Characters and Physical Characters

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## INTRODUCTION

Nowadays overweight, obesity, type 2 diabetics and heart disease are the main health problems throughout the country. The main cause of degenerative disease is our life style modification like physical inactivity, work stress, unhealthy food habits (more sugar and saturated fatty acids). In recent reports, 382 million peoples are diabetic in the world and it is expected to rise by 55% to 592 million in 2035 and still undiagnosed peoples is 175 million. Coronary heart disease is the leading killer disease in the world. Peoples are already aware of sugar and saturated fat intake in our diet. For the reduction of sugar intake food industries focused in low calorie products

(Aggarwal *et al.*, 2016).

Cookies are familiar ready to eat bakery product with lowest price and easily available. In cookies preparation more sugar and fat are used which result in a higher calorie product. Recently the ingredients like sugar, fat and refined wheat flour are altered or replaced to improve their functional properties in health aspects (Aggarwal *et al.*, 2016).

The refined wheat flour was partially replaced with millets and pulses. Similar studies helped partial replacement of refined wheat flour with barley and buckwheat (Hussain *et al.*, 2018), foxtail millet flour (Sambavi *et al.*, 2015), finger millet (Bhoite *et al.*, 2018), pearl millet flour (Kulthe *et al.*, 2018 and Florence *et al.*, 2014) were reported for cookies.

Sweeteners give color, flavor, texture, taste and shape to the finished product. But addition of sugar result in more calories and leads to diabetics also. Similar investigation for the replacement of sugar with jaggery extracted from sugar beet (Punde *et al.*, 2018), fructoligosaccharide (Handa *et al.*, 2010), stevia leaves powder (Kulthe *et al.*, 2014), sucrose and maltitol (Aggarwal *et al.*, 2016) were reported for cookies.

One gram of fat gives 9 calories and more intake of fat leads to overweight, obesity and heart disease to the human being. For reduction of fat content in the foods fat replacer can be used. Similar investigation for the replacement of fat with Polydextrose and Simplese (Aggarwal *et al.*, 2016), *Agave angustifolia* fructans (Santiago-García *et al.*, 2017), emulsion filled gel based on inulin and extra virgin olive oil (Giarnetti *et al.*, 2015), hydroxypropyl methylcellulose and inulin (Laguna *et al.*, 2014) were reported for cookies. The aim of the study was to formulate low calorie multigrain cookies with the use of refined wheat flour, finger millet flour, pearl millet flour and roasted green gram flour for multigrain flour formulation. For 100 per cent sugar replacement palm candy was used and fat was partially replaced with the help of fat replacer (polydextrose).

## **MATERIALS AND METHODS**

### **Raw Materials and Ingredients**

Refined wheat flour, pearl millet flour, finger millet flour and green gram flour, sugar, palm candy, milk powder, vanilla powder, baking powder and shortening were collected from local market in Madurai city. Fat replacer (polydextrose) obtained from Rajivi enterprises in Ahmedabad.

### **Preparation of Roasted Green Gram Flour**

Green gram was cleaned to remove stone, stalk, pods. It was roasted at 204°C for 20 minutes. The roasted green gram was grained & sieved in 60 mesh sieve to obtain gram flour.

### **Preparation of Control Cookies**

Control cookies were prepared by kneading vanaspathi with sugar. Refined wheat flour, skim milk powder, vanilla powder and required amount of water was added & made into dough. The dough was spread like a sheet and cut into small pieces with the help of cookie cutter. Cookies were arranged in trays, baked (145°C for 15- 30 minutes) and cooled (at room temperature for 15- 20 minutes). The cookies were packed in polypropylene bags and stored in room temperature (Bhoite *et al.*, 2018).

**Table 1: The Quantum of Ingredients used for Formulation of Control and Multigrain Cookies**

Ingredients	Control Formulation	Formulation with Replacement of		
		Refined Wheat Flour	Sugar	Bakery Shortening
Refined wheat flour (RWF) (g)	100	50	50	50
Finger millet flour (FMF) (g)	-	10-40 (30&40)	10-40 (30&40)	10-40 (30&40)
Pearl millet flour (PMF) (g)	-	10-40 (30&40)	10-40 (30&40)	10-40 (30&40)
Roasted green gram flour (RGGF) (g)	-	40-10 (20&10)	40-10 (20&10)	40-10 (20&10)
Sugar (g)	50	50	-	-
Palm candy (g)	-	-	20-30 (30)	30
Vanaspathi (g)	50	50	50	35
Polydextrose (g)	-	-	-	5-25 (15)
Skim milk powder (g)	5	5	5	5
Vanilla powder (g)	1	1	1	1
Water (ml)	5	5	5	5

#### **Selection of Level of FMF & RGGF and PMF & RGGF for Multigrain Flour**

To prepare the multigrain cookies - the optimized flour, FMF & RGGF and PMF & RGGF were tried in different levels (10- 40%) to partially replace the refined wheat flour. Based on the sensory evaluation score the best levels were selected and evaluated for physical & sensory parameters (Aggarwal *et al.*, 2016).

#### **Selection of Sweetener**

Palm candy and palm jaggery were selected as sweeteners to replace sugar. The sugar was replaced in weight by weight basis.

#### **Level of Sugar Replacement**

The cookies were prepared using 40, 50 & 60 per cent palm candy to replace sugar at the level was standardized.

#### **Selection of Level of Fat Replacer**

Polydextrose were selected as fat replacer. It is suitable for baked goods, confectionaries, frozen dairy desserts etc. The cookies were prepared at different levels of polydextrose (10, 20, 30, 40 and 50%) to partially replace vanaspathi. Based on the sensory evaluation score the best level was selected and used for further analysis (Aggarwal *et al.*, 2016).

#### **Procedure for Preparation of Low Calorie Multigrain Cookies**

Cookies were prepared by kneading the vanaspathi, polydextrose, ammonium bicarbonate and palm candy to creamy consistency. Dough was prepared by adding multigrain flour, skim milk powder, vanilla powder and required amount of water. Then, it was spreaded like a sheet and cut into small pieces with help of cookies cutter (Mould). Cookies were arranged in trays, baked (145°C for 15- 30 minutes) and cooled (at room temperature for 15- 20 minutes). The cookies are packed in different packaging materials like polypropylene box, polypropylene bags & aluminum foil container and stored at room temperature (Bhoiteet *al.*, 2018).

## Physical Characters

### Weight of the Cookies

Four cookies were selected randomly and weighed using digital weighing balance. The same procedure was repeated three times and the average value was taken (Inyanget *al.*, 2018 & Adeola and Ohizua 2018).

### Weight Loss

The weight loss was measured using digital weighing balance. The percentage of weight loss was measured by the difference between measuring weight of baked and unbaked cookies. The same procedure was repeated three times and taken average value (Inyanget *al.*, 2018).

### Thickness

Four cookies were selected randomly and the thickness was measured using vernier caliper with 0.01mm accuracy. The same procedure was repeated three times and the average value was taken (Sengevet *al.*, 2015 & Inyanget *al.*, 2018).

### Diameter

Four cookies were selected randomly and the diameter was measured using vernier caliper with 0.01mm accuracy. The same procedure was repeated three times and the average value was taken (Sengev *et al.*, 2015 & Inyang *et al.*, 2018).

### Spread Ratio (SR)

Spread ratio was measured using the difference between diameter and thickness. The same procedure was repeated three times and the average value was taken (Sengev *et al.*, 2015 & Inyang *et al.*, 2018).

### Bulk Density

Bulk density was the difference between weight of the sample and volume of the sample after trapping in 50 ml volumetric flask (AHMED *et al.*, 2018).

### Texture Profile

Cookies breaking strength was determined using texture profile analyzer (Baumgartner *et al.*, 2018).

## SENSORY EVALUATION

The sensory characters such as appearance/ color, flavor, texture, taste and overall acceptability were evaluated by 15 semi-trained panel members with the help of 9-point Hedonic scale (Sengevet *al.*, 2015 & Aggarwal *et al.*, 2016).

## STATISTICAL ANALYSIS

The statistical package MS Excel was used for interpreting the data in form of mean and standard deviation.

## RESULTS AND DISCUSSIONS

### Selection of Level of FMF & RGGF and PMF & RGGF for Multigrain Flour

The effects of sensory parameters in different level of multigrain cookies are presented in the Table.2. At first the significant difference was observed in sensory characters for different level of FMF and RGGF incorporated cookies. Comparison of first five treatments T5 got highest score and next T4 got highest score in all sensory characters. Other three

treatments (T1, T2 & T3), the texture, appearance, flavor and taste are not accepted in sensory evaluation. Secondly, significant difference was observed in sensory characters for different level of PMF and RGGF incorporated cookies. Comparison of last five treatments T10 got highest score and next T9 got highest score in all sensory characters. Other three treatments (T6, T7 & T8), the texture, appearance, flavor and taste are not accepted in sensory evaluation. Similar investigation for the partial replacement of refined wheat flour with barley and buckwheat (Hussain *et al.*, 2018), foxtail millet flour (Sambaviet *et al.*, 2015), finger millet (Bhoite *et al.*, 2018), pearl millet flour (Kultheet *et al.*, 2018 and (Florence *et al.*, 2014) were reported for cookies.

### **Selection of Type and Level of Sweetener**

The effects of sensory parameter in 100 percent sugar and sugar replaced cookies are presented in Table.3. Palm candy and palm jaggery was used as sugar replacer. Based on the sensory evaluation palm candy got highest score compared to palm jaggery and it gave more sweetness to the cookies without affecting other sensory attributes. The effect of sensory parameters in 40, 50 & 60 percentage of palm candy cookies are showed in Table.4. The 60 percent of palm candy got more sensory score compared to others treatments. Similar investigation for the replacement of sugar with jaggery extracted from sugar beet (Pundeet *et al.*, 2018), fructoligosaccharide (Handa *et al.*, 2010), stevia leaves powder (Kultheet *et al.*, 2014), sucrose and maltitol (Aggarwal *et al.*, 2016) were reported for cookies.

### **Selection of Level of Fat Replacer**

The effects of sensory parameters in different level of fat replaced cookies are presented in the Table.5. Observed the significant difference in sensory characters for different level of polydextrose (10, 20, 30, 40 & 50) incorporated cookies. Based on the sensory evaluation, up to 30% incorporation of polydextrose was found best in sensory characters of cookies. Above 30%, the polydextrose gave hardness to the cookies. Similar investigation for the replacement of fat with Polydextrose and Simplex (Aggarwal *et al.*, 2016), *Agave angustifolia* fructans (Santiago-García *et al.*, 2017), emulsion filled gel based on inulin and extra virgin olive oil (Giarnetti *et al.*, 2015), HPMC and inulin (Laguna *et al.*, 2104) were reported for cookies.

### **Preparation of Low Calorie Multigrain Cookies**

The effects of sensory parameters in optimized level of low calorie multigrain grain cookies are presented in the Table.6. Based on the sensory evaluation 50RWF+30PMF+20RGGF (T9) got highest score ( $7.65 \pm 0.79$ ) compared to other treatments followed by 50RWF+40PMF+15RGGF (T10), 50RWF+30FMF+20RGGF (T4) and 50RWF+40FMF+10RGGF (T5) got the scores like  $7.43 \pm 0.64$ ,  $7.33 \pm 0.777$  and  $7.27 \pm 0.61$  respectively.

### **Physical Properties of Low Calorie Multigrain Cookies**

The physical parameters of low calorie multigrain cookies were reported in the Table.7. The weight of control cookies is 43.93g and treatment cookies weight ranged from 44.2 to 37.761g. 40% PMF and 10% RGGF incorporated multigrain cookies got highest weight (44.2g) followed by 30% PMF & 20% RGGF, 40% FMF & 10% RGGF and 30% FMF & 20% RGGF got the scores like 42.56g, 42.321g and 37.761g respectively. The weight loss of control cookies is 8.71% and treatment cookies weight loss ranged from 15.31 to 8.8%. 30% FMF & 20 RGGF incorporated multigrain cookies got highest weight loss (15.31%) followed by 40% FMF & 10% RGGF, 30% PMF & 20% RGGF and 40% PMF & 10% RGGF got the scores like 13.21%, 8.85% and 8.8% respectively (Inyanget *et al.*, 2018 & Adeola and Ohizua 2018).

The bulk density of control cookies is 0.91 and treatment cookies bulk density ranged from 0.896 to 0.81. 40% PMF and 10% RGGF incorporated multigrain cookies got highest weight (0.89582) followed by 30% PMF & 20% RGGF, 40% FMF & 10% RGGF and 30% FMF & 20% RGGF got the scores like 0.83, 0.82 and 0.81 respectively (Ahmed *et al.*, 2018). The hardness of the control cookies is 0.9N and treatment cookies hardness ranged from 0.8 to 0.6N. 40% FMF & 10% RGGF have more hardness (0.8N) followed by 30% FMF & 20% RGGF, 30% PMF & 20% RGGF and 40% PMF & 10% RGGF got scores like 0.7, 0.6 and 0.6 respectively (Ahmed *et al.*, 2018).

### Physical Properties of Low Calorie Multigrain Cookies Before and After Baking

Table.8 showed the physical properties of low fat low calorie multigrain cookies. The diameter of unbaked control cookies is 14.92cm and the diameter of baked control cookies is 16.837cm. The treatment cookies diameter before baking ranged from 14.91 to 14.745cm and after baking ranged from 17.3 to 16.73cm. Comparison of before and after baking of cookies the diameter level increased. The thickness of unbaked control cookies is 4.027cm and the thickness of baked control cookies is 6.2cm. The treatment cookies thickness before baking ranged from 3.99 to 3.98cm and after baking ranged from 4.447 to 4.083cm. Comparison of before and after baking of cookies the thickness level increased. The spread ratio of unbaked cookies is 3.71 and the spread ratio of baked control cookies is 2.72. The treatment cookies spread ratio before baking ranged from 3.755 to 3.7 and after baking ranged from 4.1 to 3.77. Comparison of before and after baking all treated cookies spread ratio increased but control cookies spread ratio only decreased (Ahmed *et al.*, 2018).

**Table 2: Sensory Evaluation Score for Multigrain Cookies (9-Point Hedonic Scale)**

Treatments	Attributes				
	Appearance/Color	Flavor	Texture	Taste	Overall Acceptability
100RWF (Control)	8.8±0.414	8.53±0.74	8.73±0.46	8.67±0.49	8.68±0.486
50RWF+10FMF+40RGGF (T1)	6.4±1.55	6.93±1.16	6±1.56	7.067±1.5	6.6±1.29
50RWF+20FMF+30RGGF (T2)	6.4±1.24	6.87±1.125	6.4±1.5	6.93±1.39	6.65±1.2
50RWF+25FMF+25RGGF (T3)	6.87±1.3	7.2±1.265	7±1.25	6.73±1.33	6.95±1.178
50RWF+30FMF+20RGGF (T4)	7.4±0.83	7.6±1.12	7.8±1.014	7.8±1.47	7.65±1.07
50RWF+40FMF+10RGGF (T5)	7.87±0.52	8.067±0.59	8.2±0.86	8.27±0.7	8.1±0.53
50RWF+10PMF+40RGGF (T6)	6.4±1.45	7.13±0.99	6.067±1.22	7.07±0.96	6.67±0.91
50RWF+20PMF+30RGGF (T7)	6.8±1.47	7.47±0.91	6.6±1.4	6.8±0.77	6.92±0.967
50RWF+25PMF+25RGGF (T8)	6.8±0.862	7.07±0.594	6.87±0.92	7.07±0.7	6.95±0.5
50RWF+30PMF+20RGGF (T9)	8.07±0.7	7.87±0.74	7.73±0.96	8.07±0.88	7.93±0.66
50RWF+40PMF+10RGGF (T10)	8.27±0.7	8.07±0.8	8.33±0.62	8.13±0.74	8.2±0.63

Dates are presented as mean ± standard deviation. RWF – Refined wheat flour, FMF-Finger millet flour, RGGF- Roasted green gram flour, PMF- Pearl millet flour and T- Treatment.

**Table 3: Sensory Evaluation Score for Different Sugar Replaced Cookies (9-Point Hedonic Scale)**

Treatments	Attributes				
	Appearance/Color	Flavor	Texture	Taste	Overall Acceptability
Control (sugar)	7.33±0.9	7.13±0.92	7.47±0.83	7.27±0.8	7.3±0.67
Palm candy	7.67±0.62	7.73±0.799	7.4±0.74	7.93±0.7	7.683±0.37
Palm jaggery	7.73±0.594	7.33±0.72	7.53±0.74	6.93±0.799	7.383±0.52

Dates are presented as mean ± standard deviation.

**Table 4: Sensory Evaluation Score for Cookies in Different Percentage of Palm Candy**

Treatments	Attributes				
	Appearance/ Color	Flavor	Texture	Taste	Overall Acceptability
Palm candy (20g)	7.73±0.96	7.4±0.91	7.67±0.72	7.33±0.9	7.53±0.69
Palm candy (25g)	8.13±0.64	7.67±0.72	7.87±0.72	7.67±0.98	7.83±0.58
Palm candy (30g)	8.067±0.884	8.067±0.884	8.2±0.862	8.267±0.884	8.15±0.78

Dates are presented as mean ± standard deviation.

**Table 5: Sensory Evaluation Score for Cookies in Different Level of Fat Replacer**

Treatments	Attributes				
	Appearance/ Color	Flavor	Texture	Taste	Overall Acceptability
Control	8.4±0.74	8.4±0.74	8.27±0.7	8.4±0.74	8.37±0.48
Polydextrose (10%)	8.33±0.899	7.73±1.22	8.4±0.74	8.2±0.676	8.167±0.73
Polydextrose (20%)	8.53±0.64	7.8±0.862	7.87±0.74	7.93±0.7	8.03±0.64
Polydextrose (30%)	8.2±0.775	7.8±0.775	7.93±0.7	8.07±0.799	8±0.463
Polydextrose (40%)	8.13±0.74	6.47±0.74	6.07±0.799	7±0.65	6.92±0.51
Polydextrose (50%)	8±0.756	6.8±0.862	6.13±0.83	6.33±0.723	6.82±0.495

Dates are presented as mean ± standard deviation.

**Table 6: Sensory Evaluation Score for Low Fat Low Calorie Multigrain Cookies**

Treatments	Attributes				
	Appearance/color	Flavor	Texture	Taste	Overall Acceptability
Control	8.33±0.487	8.4±0.737	8.53±0.64	8.47±0.64	8.43±0.31
50RWF+30FMF+20RGGF (T4)	7.6±0.737	7.4±0.828	7±1.25	7.33±1.046	7.33±0.777
50RWF+40FMF+10RGGF (T5)	7.47±0.64	7.2±0.77	7.33±1.175	7.07±1.03	7.27±0.61
50RWF+30PMF+20RGGF (T9)	7.73±0.59	7.8±0.77	7.4±0.986	7.67±0.81	7.65±0.79
50RWF+40PMF+10RGGF (T10)	7.6±0.828	7.4±0.91	7.47±1.189	7.27±1.1	7.43±0.64

Dates are presented as mean ± standard deviation.

**Table 7: Physical Properties of Low Calorie Multigrain Cookies**

Parameters	Weight of the Cookies (g)	Weight Loss (%)	Bulk Density (g/ml)	Texture Profile Hardness (N)
Control	43.93±0.038	8.71±0.153	0.910	0.9
50RWF+30FMF+20RGGF (T4)	37.761±0.23	15.31±0.1	0.810	0.7
50RWF+40FMF+10RGGF (T5)	42.321±0.32	13.21±0.51	0.824	0.8
50RWF+30PMF+20RGGF (T9)	42.56±0.37	8.8±0.29	0.833	0.6
50RWF+40PMF+10RGGF (T10)	44.2±0.18	8.85±0.179	0.896	0.6

Dates are presented as mean ± standard deviation.

**Table 8: Physical Properties of Low Calorie Multigrain Cookies Before and After Baking**

Parameters	Before Baking			After Baking		
	Diameter (cm)	Thickness (cm)	Spread Ratio	Diameter (cm)	Thickness (cm)	Spread Ratio
Control	14.92±0.101	4.027±0.25	3.71±0.213	16.837±0.11	6.2±0.068	2.72±0.022
50RWF+30FMF+20RGGF (T4)	14.745±0.12	3.987±0.074	3.7±0.066	16.73±0.22	4.083±0.076	4.1±0.096
50RWF+40FMF+10RGGF (T5)	14.81±0.242	3.987±0.18	3.72±0.195	17.3±0.14	4.28±0.242	4.053±0.196
50RWF+30PMF+20RGGF (T9)	14.84±0.123	3.99±0.142	3.723±0.11	16.73±0.29	4.447±0.188	3.77±0.2
50RWF+40PMF+10RGGF (T10)	14.91±0.195	3.98±0.262	3.755±0.21	16.69±0.085	4.403±0.17	3.79±0.147

Dates are presented as mean ± standard deviation.

## CONCLUSIONS

In above study 50% refined wheat flour, 40% pearl millet flour and 10% roasted green gram flour contained multigrain flour selected as best multigrain composition and used for formulation of low calorie multigrain cookies. 30g of palm candy successfully replace the sugar and 30% of polydextrose selected as the best replacement of bakery shortening without affecting sensory attributes of cookies. In physical characters, the maximum and minimum range of cookies weight, weight loss, bulk density, hardness, thickness, diameter & spread ratio for before baking and thickness, diameter & spread ratio for after baking are 44.2 to 37.761g, 15.31 to 8.71%, 0.91 to 0.81 (g/ml), 0.9 to 0.6N, 14.92 to 14.745cm, 4.027 to 3.98cm, 3.755 to 3.7, 17.3 to 16.73cm, 6.2 to 4.083cm and 4.1 to 2.72 respectively.

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